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FOR RELEASE: TUESDAY P.M.
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PROJECT: GOLDSTONE DEDICATION (April 29, 1966)

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NEWS NASA
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GIANT ANTENNA
TO BE DEDICATED
AT GOLDSTONE, CAL.

One of the world's largest and most sensitive automatic space tracking and telemetry antennas will be dedicated officially April 29 at Goldstone, Cal.

The new antenna will be able to follow future Mariners and other spacecraft not only to Mars and Venus but even to Pluto on the outer reaches of the solar system.

The antenna, newest facility in the Deep Space Network of the National Aeronautics and Space Administration, is the United States' largest fully steerable antenna and the world's largest built for research by spacecraft.

With a parabolic aluminum dish reflector 210 feet in diameter, the new Goldstone facility, located in the Mojave Desert, will have two and one half times the range of the 85-foot diameter antennas at the network member stations in Australia, South Africa and Spain, and the other deep space facilities at Goldstone.

The Goldstone "210" will be operated by NASA's Jet Propulsion Laboratory at the California Institute of Technology.

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Dr. Eberhardt Rechtin, JPL Assistant Director, Tracking and Data Acquisition, is in charge of the Deep Space Network.

Dedication ceremonies at the hill-rimmed desert site are scheduled to include addresses by Sen. Clinton P. Anderson, chairman of the Senate Aeronautical and Space Sciences Committee; Rep. George P. Miller, chairman, Science and Astronautics Committee, House of Representatives; with NASA Deputy Administrator Dr. Robert C. Seamans, Jr., and Edmond C. Buckley, NASA Associate Administrator for Tracking and Data Acquisition, also participating. Dr. William H. Pickering, JPL Director, will be host.

Officials from the State of California, members of the Congressional space committees and representatives of NASA and JPL will join astronomers, space scientists and industrialists in inspecting the new antenna and witness a demonstration of deep space communications.

The antenna was built by the Rohr Corp. of San Diego with numerous firms participating as subcontractors in the six-year, $14-million project.

(END OF GENERAL NEWS RELEASE)

<u>BACKGROUND INFORMATION FOLLOWS</u>

THE GOLDSTONE "210" AT A GLANCE

Diameter of "dish" reflector	210 feet
Height of antenna with "dish" pointed at horizon	234 feet
Circumference of reflector	715 feet
Area of reflector	0.85 acre
Height of pedestal	34 feet
Diameter of pedestal	83 feet
Depth of pedestal below ground	11 feet
Thickness of pedestal's reinforced concrete walls	42 inches
Central tower within pedestal:	
Height above ground	73 feet
Depth below ground	33 feet
Weight of entire structure	8,000 tons
Weight of reflector and supporting alidade(mount)	2,500 tons
Weight of central tower	500 tons
Weight of pedestal	5,000 tons

The pedestal supports the five-sided steel mount or alidade which in turn supports the reflector and its tipping mechanism. The alidade stands on three points, each supporting 1,600,000 pounds, a total weight in the moving parts of nearly five million pounds, approximately 2,500 tons. The bearing pad of each point floats on an oil film (hydrostatic bearing) 0.01 inch thick.

The central tower, within and completely isolated from the pedestal, provides a vibration-free reference platform for reading out antenna pointing data.

Control room, machinery and equipment, rooms, offices, and the S-band and communications systems are housed within the three-story pedestal.

The antenna is located at NASA's tracking and data acquisition complex in the Mojave Desert at Goldstone, Calif., and is operated for NASA by the Jet Propulsion Laboratory of California Institute of Technology.

LARGE ANTENNAS AND THEIR USES

Antennas are designed for the particular work they are required to do. Many of the world's largest antennas are designed for radio astronomy. Those of the National Aeronautics and Space Administration are designed for the requirements of tracking and telemetry: to locate a spacecraft, follow its course, determine its velocity, direction, eccentricity, and period in orbit; and to communicate with it.

The great "dish" antennas (parabolic reflectors) are classified fully steerable, partially steerable, or non-steerable (limited steering capacity). The more steerable an antenna, the more maneuverable and flexible it is, a necessary requirement for NASA's antennas which must track and communicate across the sky from horizon to horizon.

Such maneuverability is not needed for radio astronomy, where the antenna may fix on a single star or galaxy.

Other factors for space tracking and telemetry include: (1) bigness of the reflector area and smoothness and uniformity of the reflector surface for communications over great distances, (2) stability in adverse conditions of wind, rain and snow, and (3) quality and reliability of electronics for receiving and transmitting.

These basic factors contribute to the capability of the Goldstone "210" for long range and sensitivity in communicating with spacecraft over hundreds of millions of miles, commanding their activities and receiving their reports.

The United States' very large antennas are:

<u>Fully Steerable Antennas</u>

210-foot diameter antenna, NASA, Goldstone, Cal. -- for missions to the moon and the planets.

150-foot diameter antenna, Air Force Cambridge Research Laboratory, Sagamore Hill Radio Observatory, Hamilton, Mass. -- for radio communications research and astronomy.

140-foot diameter antenna, National Science Foundation, Greenbank, W. Va. -- for radio astronomy.

120-foot diameter antenna, a radar-radio telescope, Air Force, operated by Lincoln Laboratory, Massachusetts Institute of Technology, Haystack Hill, Tyngsboro, Mass. -- for radio communications research and astronomy.

85-foot diameter antennas, NASA, Goldstone, Cal.; Fairbanks, Alaska; Rosman, N.C.; and Australia, South Africa and Spain -- for deep space, scientific and weather satellites and Apollo missions.

Partially Steerable Antennas

300-foot diameter antenna, National Science Foundation, Greenbank, W. Va., a single-axis antenna, like a transit -- for astronomy.

Non-Steerable Antennas

1,000-foot diameter antenna (world's largest) Department of Defense, Advanced Research Projects Agency, Acrecibo Ionospheric Observatory, Puerto Rico -- a radar-radio telescope for astronomy. The antenna is a bowl hollowed in the ground as a fixed reflector, hence, not steerable; but its transmitting and receiving beam can be steered within a 40° cone, giving limited steerability.

Foreign Antennas

250-foot diameter antenna, University of Manchester, Jodrell Bank, Cheshire, England -- fully steerable, used for astronomy.

210-foot diameter antenna, Commonwealth Scientific and Industrial Research Organization (CSIRO) Parks, New South Wales, Australia, fully steerable -- used for astronomy.

THE GOLDSTONE "210"

What it is --

The "210" represents a major step forward in antenna design, size, dish contour, and instrumentation for deep space missions. The design was developed during a two-year study launched in 1961. Construction began in 1963, and all structural components were installed by August, 1965.

Performance characteristics of the new 210 are illustrated by the Pioneer VI probe, now in orbit around the Sun. Using 85-ft. antennas, the Pioneer could be followed for six months. The new antenna will make possible far more distant tracking, to give a useful lifetime for the spacecraft of 14 months.

The Goldstone "210", because of its enormous size and the perfection of its contour, will collect enough energy from the distant signal to permit recording of data from Pioneer VI even though the strength of the signal is but one billionth of one billionth of one watt when received on Earth.

The "210" is as tall as a 21-story building,measuring 234 feet from desert floor to its apex. The entire structure, including the pedestal, weighs 8000 tons, but despite its great size and weight, it can be maneuvered as easily as the smaller 85-ft antennas.

The dish is contoured to an accuracy of less than one-quarter inch. It will operate in winds up to 50 mph and withstand winds up to 120 mph.

The reflector and its supporting structure, weighing nearly five million pounds, rotate on a pressurized oil film, or hydrostatic bearing, about the thickness of a sheet of paper. This great mass can be automatically or manually turned at speeds varying from one tenth of the slow movement of stars to a maximum approximating a man's normal walking pace.

The base of the antenna is a reinforced concrete pedestal 83 feet in diameter and weighing ten million pounds. It is founded 11 feet below ground and its 42-inch-thick walls rise 34 feet above ground.

Upon this stable base stand the rotating elements of the antenna, while within the pedestal walls are housed the control room, machinery and equipment rooms and the S-band and communications systems.

The pedestal directly supports the five-sided steel mount, or alidade, which in turn supports the towering dish and its tipping mechanism. The alidade stands on three points whose bearing pads float on oil film. Each pad supports a static load of 1,600,000 pounds. The 210-ft. diameter paraboloid reflector has a circumference of about 715 feet, forming a circle within an accuracy of .05 inch.

Through the pedestal's center, but completely isolated from it, rises a 106-ft. tower founded 33 feet below grade to provide a vibration-free platform for the instrumentation to read out antenna-pointing information in polar coordinates.

The capability of the 210-ft. antenna is a basic requirement for extension of the space exploration effort. The existence of the new antenna allows the designers of spacecraft to increase the information gathering capability of the spacecraft for future missions. Scientific experiments can be designed to yield more data, and more precise data, because of the "210" antenna capability.

This capability can also provide an increased data rate from the Moon, data transmission from a capsule on a planetary surface, television transmission from orbits about the planets and, with a series of 210's linked in an array, support manned planetary flights.

It is anticipated that antennas the size of the 210-ft. dish eventually will be constructed at other sites of the Deep Space Network around the earth.

<u>How it works</u> --

Operating and signal processing techniques used in the Goldstone 210-ft. antenna system are basically the same as those used in all the 85-ft. antennas of the Deep Space Network for tracking, data acquisition and command.

The antenna is a huge reflector tuned to collect spacecraft signals so weak that their energy is often measured as one-billionth of one-billionth of one watt. These signals are amplified, fed into receivers, the data extracted and forwarded to the command center, the Space Flight Operations Facility (SFOF) at the Jet Propulsion Laboratory in Pasadena, Cal.

Station operators begin manual tracking of the spacecraft as it rises above the horizon.

Precise frequency, time and angle data of the predicted trajectory supplied by teletype from the SFOF and from other tracking stations in the Deep Space Network help early acquisition of the spacecraft.

Operators normally achieve electronic "lock-on" in four to 10 minutes. The antenna then switches to automatic tracking mode and follows the spacecraft until it dips below the horizon.

A Simultaneous Lobing Tracking Feed mounted at the focal point and in the plane of the dish makes use of the received signal itself to accomplish automatic tracking.

This tracking feed is a horn terminating in a square throat which is subdivided into four equal apertures. Incoming spacecraft signals are divided into four parts by the four apertures. If the energies in all four areas are equal then the antenna is pointed directly at the spacecraft. If they are not equal the antenna pointing angle must be corrected.

In automatic tracking, energies from the four apertures are constantly compared one to another. Any difference is expressed as an error voltage which is sent on to the servo drives to correct the antenna pointing angle either horizontally or vertically.

At extreme ranges, however, the signal may become too faint for this tracking mode even though data are still being received from the spacecraft. A master reference system is then used in which computer data, based on the known position and velocity of the spacecraft, provide signals that drive the dish to follow the spacecraft across the sky.

The antenna pedestal supports a five-sided steel mount for the 210-ft. dish and its tipping gear. The entire assembly -- totaling five million pounds -- "floats" on an oil film or hydrostatic bearing only .01 inch thick and can rotate horizontally in a complete circle. The elevation gear will tip the reflector from a near-horizontal to a vertical position in three minutes.

The Goldstone "210", like all other DSN facilities operating at S-band (2110-2120 megacycles transmitting and 2290-2300 megacycles receiving), incorporates a Cassegrainian cone feed mounted at the center of the reflector. This shortens the connection between antenna feed and receiver and minimizes the random noise that can obscure the signal, inherent in that connection.

The Cassegrainian feed is similar in design to that of an optical telescope. Signals collected in the main dish bounce up and hit a subreflector mounted on a truss-type support extending outward from the center of the dish.

The subreflector focuses the signal into the feed horn in the Cassegrainian cone where a MASER amplifies the signal before it is contaminated by electronic noise from the rest of the receiver system.

Because heat -- even the temperature of the amplifier of the input signal -- is a major source of noise in any radio receiver, the MASER is immersed in liquid helium to hold its temperature down to minus 452 degrees Fahrenheit.

In its application to DSN antennas, the MASER accomplishes maximum amplication of the signal transmitted from the spacecraft while at the same time generating an absolute minimum of the background noise common in other amplifying systems.

A basic element of the MASER is a synthetic ruby crystal whose electrons can be excited by electromagnetic energy to higher energy levels. The ruby can then be made to release this energy at the frequency of the triggering signal.

The ruby, in a helium bath, is built into a resonant cavity in the MASER device and an oscillator, called the pump, feeds electromagnetic energy into the cavity at a frequency higher than the frequency to be amplified. This energy is stored in the atomic structure of the ruby.

The cavity is tuned to the frequency of the incoming spacecraft signal that triggers the electrons stored in the ruby to drop from their high energy level to the lower level of the received signal. To do this they lose (or radiate) energy at the frequency of the triggering signal. This released energy therefore amplifies the incoming signal.

A deep space signal is usually MASER-amplified about 40,000 times, after which it is fed into the receiver where it is further amplified.

The S-band receiver uses four separate channels: two reference channels (called sum channels) for Doppler information, spacecraft telemetry and TV signals, and two channels carrying angle tracking data for automatic antenna pointing. Data in each of the sum channels is separated from the carrier signal and transmitted to the SFOF where large scale computers translate the data into "English" for use by the engineers and scientists responsible for the mission. Tracking data of antenna position, Doppler frequency, range measurements, and time are also transmitted to the SFOF for use in spacecraft flight path determination, calculation of in-flight maneuver, and command decisions.

GOLDSTONE HISTORY AND BACKGROUND

The Goldstone Space Communications Station is the primary station of the worldwide Deep Space Network (DSN), a space tracking and communications network maintained by the National Aeronautics and Space Administration with system management and technical direction provided by the Jet Propulsion Laboratory of the California Institute of Technology.

The DSN is the NASA facility for tracking and two-way communications with unmanned vehicles in deep space, as distinguished from other NASA networks such as the Scientific Satellite Network, which tracks earth-orbiting scientific, meteorological and communications satellites, and the Manned Space Flight Network which tracks the manned spacecraft of the Gemini and Apollo programs.

Other DSN stations are located at Johannesburg, South Africa; Woomera and Canberra, Australia; and Madrid, Spain. Support facilities include a monitoring station at Cape Kennedy.

JPL operates the U.S. stations. Overseas stations are staffed and operated by government agencies of their respective countries under agreement with the U.S. and with assistance of U.S. personnel.

Goldstone was the first Deep Space facility constructed after the establishment of NASA in 1958, and sleeping bags and snake bite kits were standard equipment among the JPL engineers who moved into the Mojave Desert some 50 miles north of Barstow to begin the job.

The location, like that of all other DSN stations, was selected because it was remote from electronic disturbance of radio and television transmission, and because its bowl-shaped terrain affords further shielding from interference. Remoteness from encroachment by environmental noise is a factor in station longevity.

Today, through NASA leasing arrangement with the U.S. Army, the Goldstone complex occupies 72 square miles of land belonging to the Fort Irwin military reservation. The DSN station includes four separate facilities -- Pioneer, Echo, Venus, and Mars. Each facility has its own antenna and tracking system, the new facility being the largest in the DSN.

Pioneer, the original Goldstone station, went into construction in the spring of 1958, when JPL still was under contract to the Army Ordnance Corps. The station was ready in time the track the Pioneer III spacecraft launched December 6, 1958. Just a few days before -- on December 3, 1958 -- JPL and Goldstone passed to jurisdiction of the newly created NASA.

Goldstone has since contributed to such notable U.S. deep space achievements as Pioneer IV, the first U.S. probe to reach Earth-escape velocity, and the first to be tracked successfully beyond the Moon; Pioneer V, which was tracked more than three million miles out; and Project Echo, the first experiment with passive communications satellites.

Goldstone radioed commands to Mariner II, the 1962 Venus mission which established a number of historic milestones in space flight: the first successful mid-course maneuver directed from Earth; the first successful instrument scan of another planet; and the first successful data transmission at a distance of more than 54 million miles.

It was at Goldstone that the TV signals were received and recorded from the Ranger VII mission which gave the world its first close-up photographic look at the lunar surface. A similar feat was performed again in 1965 when Mariner IV, after a seven months journey, radioed back the first pictures of the surface of Mars.

Goldstone is a self-sufficient station. It has its own roads, its own power and telephone system, and does its own maintenance and repairs. A good highway from Barstow provides ready access to the station complex. Nearby Goldstone Dry Lake, from which the station takes its name, is used as an airstrip for light aircraft that provide daily shuttle service to Burbank.

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Goldstone's permanent buildings are of concrete block construction and air conditioned against the desert climate. These include personnel facilities, offices, laboratories and operations control rooms.

As the DSN's primary station, Goldstone functions as the research and development center to extend the communications range and data acquisition capability of the entire network. It is the proving ground for advances in DSN techniques, and prototypes of all new equipment are tested here before they are approved for installation overseas.

Goldstone's Venus facility, for example, is now operating an experimental transmitter at 100,000 watts. All other DSN facilities operate transmitters at 10,000 watts. If the higher power proves feasible it may be extended to all other stations in the network.

The goal of the Deep Space Network is to standardize major equipment to assure uniform high performance, reduce the cost of spares, and establish standards of training, maintenance, checkout, and countdown procedures.

Prior to shipment overseas, equipment is field-tested at Goldstone. Goldstone personnel also serve as consultants and trouble shooters for the DSN.

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